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IS 1448-118 (1985): Methods of Test for Petroleum and its Products, Part 118: Naphthalene Hydrocarbons in Aviation Turbine Fuels by Ultraviolet Spectrophotometry [PCD 1: Methods of Measurement and Test for Petroleum, Petroleum Products and Lubricants]

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Bhartṛhari—Nītiśatakam
“Knowledge is such a treasure which cannot be stolen”

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Indian Standard

METHODS OF TEST FOR PETROLEUM AND ITS PRODUCTS

[P : 118]

NAPHTHALENE HYDROCARBONS IN AVIATION TURBINE FUELS BY ULTRAVIOLET SPECTROPHOTOMETRY

UDC 665·6/7 : 665·743·3 : 543·42 : 547·652·1

Adapted from ASTM D 1840-81

1. SCOPE

1.1 This method covers the determination by ultraviolet spectrophotometry, of the total concentration of naphthalene, acenaphthene, and alkylated derivatives of these hydrocarbons in straight-run jet fuels containing not more than 5 percent of such components and having end points below 315°C. The method determines the maximum amount of naphthalenes that could be present.

2. OUTLINE OF THE METHOD

2.1 The total concentration of naphthalenes in jet fuels is determined by measurement of the absorbance at 285 nm of a solution of the fuel at known concentration.

3. SIGNIFICANCE

3.1 This test for naphthalene hydrocarbons is one of a group of tests used to assess the combustion characteristics of aviation turbine fuels of the kerosene boiling range.

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4. DEFINITIONS

4.1 Transmittance (T) — The ratio of the radiant power (P) transmitted by the sample to the radiant power (P_0) incident on the sample.

$$T = P/P_0$$

4.2 Absorbance (A) — The logarithm to the base 10 of the reciprocal of the relative transmittance (T).

$$A = \log_{10} (1/T) = - \log_{10} T$$

4.3 Absorptivity (a) — The absorbance divided by the product of the concentration of the sample and the sample path length, $a = A/bc$, where A is the absorbance defined in **4.2**, b is the sample cell path length in centimetres and c is the concentration as defined in **4.4**.

4.4 Concentration (c) — The quantity of sample contained in a unit quantity of solvent. In this method it is expressed in grams per litre.

4.5 Under the conditions of this method, $T = 10^{-abc}$ so that $-\log_{10} T = abc = A$.

5. INTERFERENCES

5.1 Interferences add to the apparent naphthalene content. Phenanthrenes, dibenzothiophenes, biphenyl benzothiophenes, and anthracenes interfere if present. The end point limitation of 315°C, will minimize this interference except for benzothiophenes and biphenyls. The contribution to measured naphthalene content by the presence of 1 percent of such interfering compounds can be estimated from the following table:

Type of Interfering Compound	*Error in Percentage of Naphthalenes Caused by 1 Percent Interfering Compound*
Phenanthrenes	2
Dibenzothiophenes	2
Biphenyls	1
Benzothiophenes	0·6
Anthracenes	0·1

5.2 Saturated hydrocarbons, olefins, thiophenes, and alkyl or cycloalkyl derivatives of benzene will not interfere.

6. APPARATUS

6.1 Spectrophotometer — Equipped to handle liquid samples. The instrument shall be capable of measuring absorbance with a repeatability of ±0·5 percent or better from an average at the 0·4 absorbance level in the spectral region between 280 and 240 nm with a nominal band width of 1 nm or less. The spectral positions shall be reproducible to within 0·1 nm.

6.2 Vitreous Silica Cell — Two, having path lengths of 1·00 ± 0·005 cm.

6.3 Pipette — Calibrated with *iso*-octane for volume delivery.

6.4 Lens Paper

7. SOLVENTS

7.1 Spectroscopic Solvent — *Iso*-octane (*see* Note 1) or cyclohexane (*see* Note 2).

CAUTION— Extremely flammable, harmful if inhaled.

NOTE 1 — Spectroscopic-grade *iso*-octane is available commercially*. Technical grade *iso*-octane is a satisfactory base stock for the preparation of spectroscopic solvent. Allow about 4 or 5 litres of this material to percolate through a column of activated silica gel 200-mesh, 50·8 to 76·2 mm in diameter and 0·6 to 0·9 m in depth. Collect only the portion of the solvent that has a transmission compared to distilled water greater than 90 percent over the entire spectral range from 240 to 300 nm. Store in scrupulously clean glass-stoppered bottles and always keep covered. In general it will be best to use a fresh portion of silica gel in preparing a new batch of solvent. However, the gel can be reactivated by pouring 500 ml of acetone through the column, draining, drying by suction, and heating the gel in thin layers in an oven at 400°C until white colour is restored. Activated silica gel is stored in closed containers.

NOTE 2 — Cyclohexane may be used as an alternative to *iso*-octane in this procedure and is commercially available in spectroscopic grade.

7.2 Solvents for Cleaning Cell — Residue free acetone or ethyl alcohol.

CAUTION — Extremely flammable, harmful if inhaled.

8. CALIBRATION AND STANDARDIZATION

8.1 Instead of direct calibration of the spectrophotometer with known naphthalenes, the average absorptivity of the C_{10} to C_{13} napthalenes at 285 nm may be taken at 33·7 litre per gram-centimetre. The data used to calculate this average are given in **9.**

9. PROCEDURE

9.1 Check carefully handling and cleaning of cells and glassware, instrument adjustments, and method of absorbance measurement.

9.2 Prepare three dilutions of the sample as follows.

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*Spectroscopic-grade *iso*-octane and cyclohexane are available from Distillation Products Industries, Eastman Kodak Co., Rochester, N.Y. and from the Special Products Div., Phillips Petroleum Co, Bartlesville, Okla.

9.2.1 *First Dilution* — Add 10 to 15 ml of spectroscopic solvent to a clean, dry, glass-stoppered, 25-ml volumetric flask. Weigh out approximately 1 g of sample in the flask, dilute to volume with spectroscopic solvent, and mix thoroughly.

9.2.2 *Second Dilution* — Pipette 5·00 ml of the first dilution into a 50-ml glass-stoppered volumetric flask, dilute to volume with spectroscopic solvent, and mix thoroughly.

9.2.3 *Third Dilution* — Dilute 5·00 ml of second dilution to 50 ml in the same manner as in **9.2.2**.

9.3 Measurement of Absorbance — Pipette portions of the third dilution into the sample cell of the spectrophotometer. Cover the cells immediately to prevent transfer of aromatic hydrocarbons from the sample cell to the solvent cell. Check the windows of the absorption cells and make certain they are clean. Measure the absorbance. Record the absorbance of the sample as compared to the solvent at 285 nm (*see* Note).

NOTE — The dilution of the sample should be controlled so that absorbance readings fall within a range of 0·2 to 0·8 for maximum reproducibility of results. To accomplish this it may be necessary to use an alternative third dilution such as 10 ml of the second dilution to 25 ml with solvent.

9.4 Determination of Cell Correction — Measure and record the absorbance of the solvent-filled sample cell as compared to the solvent-filled solvent cell.

10. CALCULATIONS

10.1 Calculate the mass percentage of naphthalenes in the sample as follows:

$$\text{Naphthalenes, mass, percent} = (AK/33{\cdot}7M) \times 100$$

where

A = corrected absorbance (observed absorbance minus cell correction) of the dilution measured;

K = equivalent volume of solvent, in litres, if the dilution had been made in a single step. For the first, second and third dilutions the value of K shall be 0·025, 0·25 and 2·5 respectively. For the suggested alternative the value of K shall be 0·625;

M = mass, in g, of the sample used; and

33·7 = the average absorptivity of C_{10} to C_{13} naphthalenes in litres per gram-centimetre.

10.2 Calculate the volume percentage of naphthalenes as follows :

$$\text{Naphthalenes, volume, percent} = A \times (B/C)$$

where

A = percentage of naphthalenes by mass;
B = relative density of the total fuel at 15°C/15°C; and
C = relative density of the naphthalene at 15°C/15°C is 1·00.

11. REPORT

11.1 Numerical values of volume percent naphthalene are reported to the nearest 0·01 percent.

12. REFERENCE SPECTRA

12.1 Absorptivities of individual naphthalene hydrocarbons at 285 nm are derived from data in the API catalogue of ultraviolet spectral data issued by Research Project 44 as given in Table 1 (*see* Note).

NOTE — The arithmetic average of the above absorptivities is 33·7. The reliability of the average absorptivity as a measure of selected individual naphthalenes may be estimated from Table 1.

TABLE 1 DATA ISSUED BY API RESEARCH PROJECT 44

COMPOUND	API Sl No.	l/g cm
Naphthalene	605	28·5
1-methyl naphthalene	539	32·0
2-methyl naphthalene	572	22·9
1, 2-dimethyl naphthalene	215	37·3
1, 3-dimethyl naphthalene	216	36·4
1, 4-dimethyl naphthalene	217	43·5
1, 5-dimethyl naphthalene	218	54·0
1, 6-dimethyl naphthalene	219	36·4
1, 7-dimethyl naphthalene	220	36·0
1, 8-dimethyl naphthalene	221	46·0
2, 3-dimethyl naphthalene	222	22·0
2, 6-dimethyl naphthalene	226	21·3
2, 7-dimethyl naphthalene	224	23·5
1-*iso*-propyl naphthalene	203	31·7

13. PRECISION

13.1 Result of duplicate tests shal lnot differ by more than the following amounts.

Repeatability	*Reproducibility*
0·05 volume, precent	0·11 volume, percent

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(*Page* 1, *clause* 1.1) — Add the following after 1.1:

'**1.2** This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.'

(*Page* 5, *clause* 13.1) — Add the following after 13.1:

'NOTE — Although the method permits the use of either isooctane or cyclohexane as diluents, recent studies have shown cyclohexane to produce naphthalene values which are about 6 percent higher than those produced by iso-octane. A survey of users has shown iso-octane to be in general use and it is intended that the use of cyclohexane should be dropped. Although it is believed that isooctane was the solvent used in the original precision programme, this is not certain and a new precision programme is under consideration.

ANNEX A
(Mandatory Information)
PRECAUTIONARY STATEMENTS

A-1.1 Isooctane

Danger — Extremely flammable.

Harmful if inhaled. Vapors may cause flash fire.

Keep away from heat, sparks, and open flame.

Keep container closed.

Use with adequate ventilation.

Avoid build-up of vapors and eliminate all sources of ignition, especially nonexplosion proof electrical apparatus and heaters.

Avoid prolonged breathing of vapor or spray mist.

Avoid prolonged or repeated skin contact.

A-1.2 Cyclohexane

Danger — Extremely flammable